Center Independent Research & Development: GSFC IRAD

Photon-Counting Microwave Kinetic Inductance Detectors (MKIDs) for High Resolution Far-Infrared Spectroscopy

Completed Technology Project (2014 - 2016)

Project Introduction

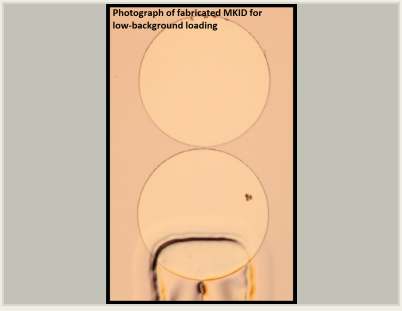
We are developing ultrasensitive Microwave Kinetic Inductance Detectors (MKIDs) for high resolution far-infrared spectroscopy applications, with a long-term goal of achieving photon-counting sensitivity in low photon backgrounds.

MKIDs are superconducting thin film microwave resonators made in planar transmission line circuits. These resonators experience a change in resonance frequency and quality factor when incident far-infrared power is absorbed in the inductor region of the detector. This perturbation can be observed by monitoring the resonator with a microwave tone on resonance via a microwave feedline. MKIDs are therefore intrinsically adapted for frequency multiplexing and appealing for use in next-generation kilo- to mega-pixel detector arrays. We are motivated to pursue developments which will lead to MKIDs with photon-counting capability, since this provides a significant sensitivity benefit over power detection.

A photon counting detector must have energy resolution less than the photon energy, a bandwidth faster than the photon arrival rate, and high efficiency. To achieve this performance, two attributes are desirable: 1) An MKID design that demonstrates the required sensitivity, and 2) the capability to produce devices whose response and noise are consistent with the model. Design optimization depends on precise knowledge of materials parameters. We are evaluating superconducting films with simple 1- or 2-layer MKID devices in order to characterize the key film properties which contribute to detector response and noise, and determining fabrication techniques which will allow us to improve and reproduce these film properties. We will implement a down-selected superconducting material into a far-IR-coupled MKID design, and fabricate and test these devices.

Anticipated Benefits

This work will benefit future cryogenic balloon-borne missions, or future Decadal survey-recommended Far-IR Surveyor, or Explorer-class space flight missions (such as the SPICA, SPIRIT, SPECs mission concepts).



Fabrication of Materials

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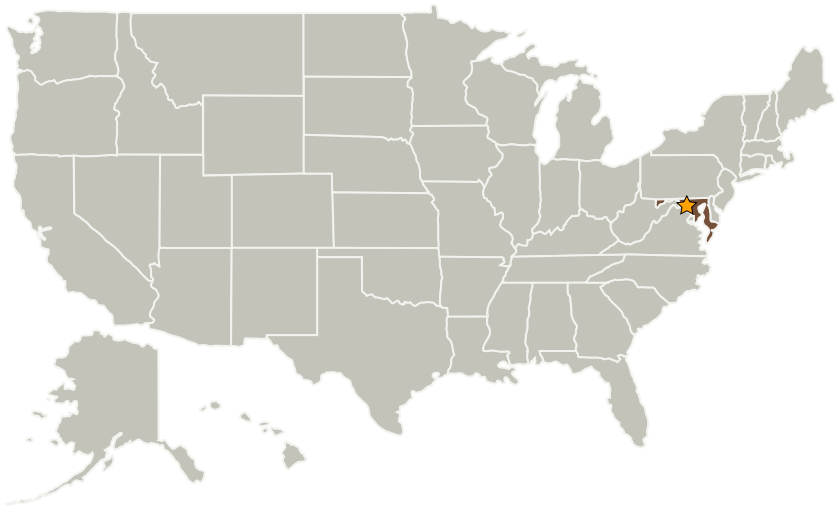
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Goddard Space Flight Center(GSFC)	Lead Organization	NASA Center	Greenbelt, Maryland

Co-Funding Partners	Type	Location
National Institute of Standards and Technology(NIST)	US Government	Boulder, Colorado
University of Maryland-College Park(UMCP)	Academia	College Park, Maryland

Primary U.S. Work Locations
Maryland

Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Goddard Space Flight Center (GSFC)

Responsible Program:

Center Independent Research & Development: GSFC IRAD

Project Management

Program Manager:

Peter M Hughes

Project Manager:

Terence A Doiron

Principal Investigator:

Emily M Barrentine

Co-Investigators:

Samuel H Moseley
Omid Noroozian
Ari D Brown
Edward J Wollack
Thomas R Stevenson
Kongpop U-yen

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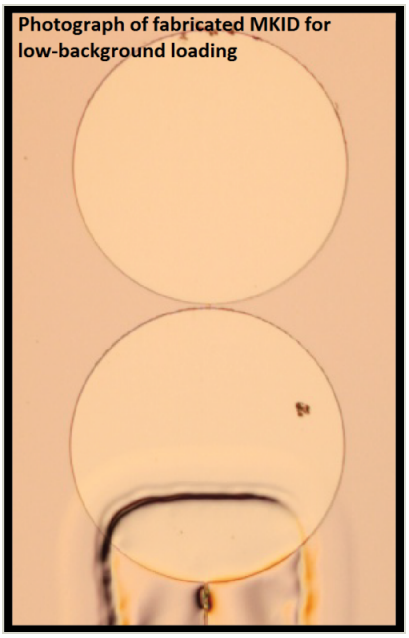
Images



MKID
Fabrication of Materials
(https://techport.nasa.gov/image/16505)

Links

GSC-16339-1
(no url provided)

GSC-16602-1
(no url provided)

GSC-16883-1
(no url provided)

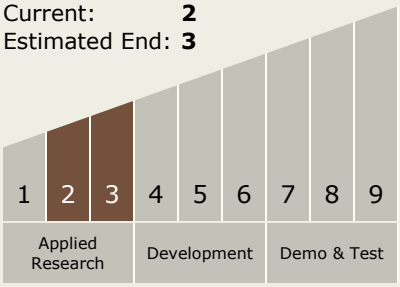
GSC-17620-1
(no url provided)

Project Website:

http://aetd.gsfc.nasa.gov/

Technology Maturity (TRL)

Start: **2**
Current: **2**
Estimated End: **3**



Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.1 Remote Sensing Instruments/Sensors
    - TX08.1.1 Detectors and Focal Planes